DISTRACTING DEVICE FOR ORTHODONTIC/OROSURGICAL PURPOSES ON THE LOWER JAW

The present invention relates to a distraction apparatus for orthodontic, orthognathic and oral/maxillofacial surgery applications on the mandible which is used for distraction osteogenesis of a dentate anterior bone segment.

The present distraction apparatus has its application in orthodontics, orthognathic surgery and general oral and maxillofacial surgery. It is its purpose to provide the surgeon with a tool to distract bony segments, e.g. in the area of the anterior mandible. In particular, such an apparatus should enable the surgeon to achieve a more prominent chin or to translate an anterior bone segment including the integrated teeth and to change its dental axis, if required.

In oral/maxillofacial surgery there is often the need to precisely move a bony segment gradually, to rotate it into a different position or to combine both movements. Thereby, the movement is achieved over several days after the osteotomy in the sense of a so-called callus distraction.

One application is genioplasty, where the anterior lower edge of the mandible is detached and reattached in a more advanced position by means of osteosynthesis screws; the goal of this procedure is to increase the prominence of the chin, e.g. in the case of a too posterior position, in order to provide the patient with a more aesthetic facial profile. Typically, this movement is done in one step which may result in discontinuities in the bony profile at the osteotomy site and therefore also the soft tissue profile of the lower mandibular edge. Furthermore, the soft-tissue in the area of the chin are heavily stretched and strained in a one-step translation.

In another application there is the need, to loosen an anterior segment of the alveolar ridge with the included dentition and to move this segment more to the front and/or to rotate it, e.g. to gain more space for the teeth in the case of an anterior dental crowding, or to provide some more length to a mandible which is slightly to short relative to the maxilla, in order to achieve an improved occlusion. Such movements were also done in one step, in the past. This has the disadvantage that it limits the achievable movement since sufficient overlapping between the osteotomy surfaces has to be retained. Furthermore also

here the soft tissues are heavily stretched which can result in dehiscence of the mucosa in the area of the osteotomy.

It is the object of the present invention to prevent the described disadvantages of current appliances and methods and in particular to provide an apparatus which enables the desired corrections of the mandible with respect to a frontal bone segment.

This object is achieved by means of a distraction apparatus for orthodontic, orthognathic and oral/maxillofacial surgery in the mandible with the purpose of distracting a dentate frontal bone segment. This distraction apparatus is characterized by being construed from a first module and a second module where the first module essentially has an U-shape approximating the dental arch and features a middle section and on both sides thereof an end-section where the corresponding end-section is connected to the middle-section via a linear distraction element and where each end-section includes fixation means, and where the second module which has fixation parts can be assigned to an anterior bony segment to fixate it.

With the present apparatus it is possible to achieve a gradual displacement of a frontal bone segment in the sense of a callus distraction. The distraction is done continuously by distracting by means of the two distraction modules in short time intervals. The second distraction module serves the purpose of rotating the frontal bone segment in the sagittal plane.

With the inventive apparatus a gradual displacement respectively pivoting or rotation of the frontal bone segment into a desired position is possible; in comparison to previous surgical methods, a longer movement distance can be achieved, as by the continuous distraction by means of the two linear distraction modules the soft-tissues can adapt to the changed bone geometry during the course of the distraction. Furthermore, the connection by the callus makes an overlap of the osteotomy surfaces unnecessary.

In one embodiment of the distraction apparatus, the corresponding end segments of the first distractor module have fixation elements for the fixation of lateral teeth.

These end segments of the first distractor module can contain fixation elements for a fixation by means of bone screws on the mandible.

In a preferred embodiment of the distraction apparatus, the corresponding distraction element which connects the mid-segment with the end-segment of the first distractor module is constructed from at least three elements which are connected to each other. Thereby, the first element takes the form of a sleeve and inside of it the second and third element are pivoted, where the second and the third element are screwed into the first element with threads in opposite rotation sense such that under rotation of the first element in one or the other sense the distraction element is shortened or lengthened.

In order to make the distraction device easy to handle for the surgeon, there is a section point in the area of the corresponding distraction element. In the area of this section point the end segment can be solved or separated from the mid-segment. Therefore, it possible that the surgeon first connects the end segment on the jawbone of the patient and only then connects and fixates the distraction elements and the mid-segment.

Besides of a fixation of the end-segments on the jawbone with bone screws it is also possible to fixate the end-segments on the teeth, for example with a clips or clamps. A further fixation possibility of the end-segments is to screw them on by the help of a pin with single-sided threat, where on the other end opposed to the thread a sleeve or tube is mounted into which the end-segment of the first distractor module is inserted. Such a fixation with a sleeve or a tube can also be achieved by fixating it, e.g. welding it to a metal band which is positioned around a tooth and whereby the axis of the sleeve or tube is about horizontal. Into this sleeve or tube the end-segment of the first distractor module can be inserted and if desirable fixated.

The second distractor module can take the form of a hinge with two hinge parts where one hinge parts is related to the mandibular and the other is related to the frontal bone segment to be distracted.

The hinge axis should preferably run about parallel to the occlusal plane and vertical to the sagittal plane.

In order to alleviate the use of such a hinge, it can contain a stop position to limit the pivoting range of the hinge parts, such that the hinge can only be rotated in the required rotation sense in order to correct the axis of the frontal bone segment.

The fixation parts of the second distractor module can be formed by drill holes. Such drill holes can take the form of a slotted hole or several slotted holes such that in the area of the slotted holes a variable fixation point is possible which can be selected by the surgeon during the operation according to his needs.

Such a slotted hole can be formed by overlapping drill holes such that discrete fixation positions are defined.

In a further embodiment of the second distractor module, a guiding sleeve is inserted into the slotted hole, which is movable along the slotted hole; such a guiding sleeve has a drill hole or a slot, into which a fixation screw can be inserted with which a fixation of the guiding sleeve on the frontal bone segment is possible. Such a guiding sleeve could also take a form which makes it possible to clamp it into the slotted hole.

For a shifting of moving of the guiding sleeve and therefore of the bone segment fixated thereto, a linkage inserting into it can be arranged. With the help of this linkage, the part of the second distractor module which carries the guiding sleeve can be rotated about the hinge axis. Such a linkage can be tautened by a screwing element held in a bearing, such that a tensile force is exerted onto the guiding sleeve. By tautening of this linkage, a translation of the segment relative to the guiding sleeve and to the hinge can be achieved. Then a rotation about the axis can be achieved by means of springs of similar parts fixated on the dentition.

In a further embodiment one of the hinge halves of the second distractor module is formed in a V-shape in order to arrange a fixation part on each of the free end of the both legs. In connection with such a V-shaped arrangement of one of the hinge halves an additional fixation point can be provided at the area of junction of the both legs.

A further preferable embodiment of the distraction apparatus is obtained if the second distractor module is swivel-mounted and/or pivoting on the first distractor module and is in a fix relation relative to it. From the

surgical point of view, this embodiment is then preferable, if the whole anterior corpus (the complete dentate front segment of the mandible including the chin) is to be moved towards anterior, where, depending on the facial profile, the chin needs to be moved more anterior then the incisal edge of the anterior mandibular dentition.

In the above mentioned further embodiment, the second distractor module can take the form of a cantilever, where in this cantilever is then connected to the mid-segment of the first distractor module and wherein on the cantilever there are fixation means provided for the frontal bone segment.

Furthermore, in this further embodiment the second distractor module can be an U-shaped cantilever with two legs and a mid-segment connecting the two legs, wherein the mid-segment is connected to the mid-segment of the first distractor module and wherein the free ends of the two legs have fixation means.

The second distractor module can also be an essentially beam-shaped cantilever which has on the free end fixation means.

For a distraction of the frontal bone segment in cranio-caudal direction, the cantilever can be lengthened or shortened by means of an adaptation mechanism; such an adaptation mechanism my contain a spindle drive with shaft joint.

Further details and characteristics of the invention are evident from the following description by means of the drawings

In the drawings:

Figure 1a shows a frontal view of a first embodiment of a distractor for the distraction of a frontal bone segment with a first distractor module running along the dental arch and a second distractor module, where the second distractor module takes the shape of a hinge;

Figure 1b shows a side view of the arrangement in figure 1 seen from the point of view 1b in figure 1a, prior to the begin of the distraction;

Figure 1c shows the second distractor module of Figure 1 in an enlarged depiction, in a top view and also in a side view;

Figure 1d shows a view, comparable to the one in Figure 1b, but in a translatory phase;

Figure 1e shows a view corresponding to Figure 1b and 1d, towards the end of the treatment, after moving the bone segment towards anterior by translation and subsequent rotation about the hinge axis;

Figure 2 shows a modified embodiment of the upper leg of the hinge-like second distractor module with different discrete positions guiding the bone screw;

Figure 3 shows a further variation of the upper segment of the hinge-like second distractor module with a guiding sleeve positioned in a slotted hole;

Figure 4a shows a further variation of the upper segment of the hinge of the second distraction module, which contains an additional linkage with adaptation mechanism;

Figure 4b shows the second distractor module of Figure 4a schematically in an anatomic arrangement, seen in a side view;

Figure 5a shows a further embodiment of the hinge-like second distractor module for the advancement of the chin (genioplasty);

Figure 5b shows a side view of the distractor in Figure 5a in an anatomic arrangement for the advancement of the chin in the context of a genioplasty;

Figure 5c shows the same embodiment as Figure 5b in a front view prior to the begin of the distraction;

Figure 5d shows the same distractor as Figure 5b during the course of the treatment; the bone segment has already been advanced a little distance;

Figure 5e shows the same distractor as in Figure 5b in the frontal view after the end of the active distraction;

Figure 5f shows the bony contour and the resulting soft tissue contour when using conventional one-step genioplasty in the top view;

Figure 5g shows the bony contour and the resulting soft tissue contour as it can be obtained with the invented distractor, in the top view;

Figure 6 show a further embodiment of the distractor where the first distractor module and the second distractor module are directly connected to each other;

Figure 7 shows the distractor of Figure 6 as it is arranged on a schematically depicted mandible;

Figure 8a shows the arrangement as depicted in Figure 7, in a view cranial onto the mandible with a distraction in transversal direction;

Figure 9 shows a distractor, comparable to the one in Figure 6, whereby, however, the second distractor module is in contrast to an U-shaped part built by a beam-like cantilever; and

Figure 10 shows the arrangement in Figure 9 in a side view, where the beam-shaped cantilever is sectioned along its longitudinal axis.

Figure 1a shows a first embodiment of a distractor for orthodontic/orthognathic and maxillofacial surgery purposes on the mandible for the distraction of a frontal bone segment which, as depicted in Figure 1a, contains the corresponding frontal teeth; the distractor is nevertheless also then applicable, if the frontal dentition is not present. The distractor encloses a first distractor module 1 and a second distractor module 2. The first distractor module 1 shows an essentially U-shaped form, approaching the dental arch and includes a mid-segment 3 as well adjacent on both sides a respective end-segment 4. Between each end-segment 4 and the mid-segment 3 there is a linear distraction element 5 inserted. Such a linear distraction element is constructed - as also clarified in figure 1b - from a first element 6 and a second and third element 7 and 8, respectively. The first element 6 is a sleeve-shaped part with a threaded beam 9 pivoting inside of it, which extends on both sides of the first element 6, with a thread in opposing rotation sense, respectively. The two threads with opposing rotation sense are inserting into corresponding female threads of the corresponding second and third element 7 and 8. As can be seen in figure 1b, the first element 6 has drill holes into which a tool can be

engaged to rotate the first element 6 and therefore the threaded beam 9.

It should be pointed out, that the linear distraction element 5, as it is depicted in the figures, also may feature a composition in contrast to the depicted embodiments, in which the middle, first element 6 has a sleeve with two counter rotational female thread portions, into which the second and third element 7 and 8, taking the form of male threaded beams are screwed in. When rotating the first element 6 in one or the other direction, the linear distraction element 5 can be shortened or lengthened.

The two end-segments 4 of the first distractor module 1 are fixated to one or several suitable teeth by means of connection to a metal band which is positioned around such teeth.

The mid-segment 3 is also connected to the frontal dentition as evident in figures 1a and 1b.

The second distractor module 2 takes in the embodiment depicted in figures 1a and 1b the form of a hinge 14 with a

first, lower hinge-half 10 and a second upper hinge-half 11. The lower hinge-half 10 furthermore includes two legs with each featuring a hole for bone screws on both ends and a screw hole on the connection of both legs. The second, upper hinge-half 11 takes the form of a single leg which has a slotted hole 12 for the connection by a bone screw.

The lower hinge-half 10 is screwed to the mandibular bone by means of customary bone screws, marked 13 in all figures. The upper hinge-half 11, however, is screwed to a loose mandibular bone segment as depicted in figure 1a.

It should be pointed out that the second distractor module having the form of a hinge 14 has a stop position 15, which can be seen in the side view of the hinge 14 in Figure 1b. This stop position is formed by a leading edge of the lower hinge-half 10 against which the second, upper hinge-half 11 abuts, such that a rotation of both hinge-halves 10, 11 seen from the direction of the upper hinge-half 11, is limited in the clockwise direction. Such a stop position is helpful for the surgeon to maintain the base position as depicted in Figure 1b.

By means of the slotted hole 12 in the upper hinge-half 11 the second distractor module can be moved in a certain range and can therefore be adapted to the specific circumstances in order to serve as bearing for a bone screw in a certain range of heights. As can be seen in the side view of Figure 1b, the upper hinge-half 11 is shifted in its longitudinal axis relative to the lower hinge-half 10, in order to provide sufficient space for an advancement of a bone segment, the motion path being defined by the free thread portion of screw 13 in Figure 1b. This embodiment is also elucidated in the enlarged depiction of Figure 1c.

While one leg 11 of the hinge 14 is screwed to the frontal bone segment of the mandible UKFS which has be cut off along an osteotomy line HOT, the other lower hinge-half 10 is screwed to the anterior lower mandibular rim UKR. It is important to note that besides of the screw 13, which is held in the upper hinge-half 11 and holds the frontal bone segment of the mandible UKFS, the frontal bone segment remains connected to the remaining mandible also through the soft tissues which are not shown in the drawing, as well as through the first distractor module 1, which is fixated as already mentioned above on the dentition.

Based on this construction of the distractor, the possibility of a linear distraction is given by means of the two distraction elements 5, which are related to the first distractor module 1, besides of a rotation of the mandibular front segment UKFS against the lower mandibular rim UKR by means of the second distractor module 2 which takes the form of a hinge 14. Although the two distractor elements 5 which are relating to the first distractor module 1 are not oriented in a parallel fashion, the movement of the mid-segment 3 when prolonging the distraction element 5 creates no problems due to the elasticity of the wire appliances which are held on the teeth by means of orthodontic brackets. The distractor is shown in figures 1a and 1b in an initial position before start of the active distraction.

It should be pointed out, that the same reference numbers are used for comparable elements in the single figures as far as they show identical or similar embodiments.

Also, in the drawings the acronyms UKR (lower mandibular rim), HOT (horizontal osteotomy line) and UKFS (anterior mandibular bone segment) are used while SZK stands for incisal edge of the incisors.

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In Figure 1d a gradual, translational advancement of the front segment is shown. This movement is manly achieved by turning of the bone screw 13 which is assigned to the upper hinge-half 11. By rotating the bone screw 13 in clockwise direction it advances into the bone segment (UKFS) and therefore pulls it towards anterior. The advancement starts about 5-7 days after the osteotomy, whereby the daily advancement movement is 0.5-1 mm. Simultaneously, the orthodontic first distractor module 1 is activated by means of the two distraction elements 5 in such a manner that a translation along the horizontal osteotomy surface (HOT) is taking place. Therefore, the distraction is done as shown again in Figure 1d by means of the distraction element 5, but also with the bone screw 13 which is relating to the upper hinge-half 11, by screwing it into the bone segment. The tightening of the bone screw 13 results in an advancement of the base of the bone segment. Simultaneously, the distraction elements effect a rotation of the segment about the hinge axis 21.

As depicted in Figure 1e, it is possible to introduce subsequently to the translation (see Figure 1d) a slight tilting of the bone segment by activating the distraction elements 5, which results in a further advancement of the

incisal edge (SZK) and changes the dental axis. This may be desirable, for instance, if the dental axis was reclined too much towards posterior. The tilting movement is controlled exclusively by the first distractor module 1 with the distraction elements 5, while the upper bone screw 13 which is relating to the upper hinge-half 11 is usually not activated anymore.

Figure 2 shows an embodiment of the second upper hinge-half 11 of the second distractor module. In this embodiment, the slotted hole of the upper hinge-half 11, as visible in Figures 1a and 1c, is replaced by several overlapping drill holes 16. These overlapping holes form several discrete positions in which the bone screw 13 can be inserted. Assuming a minimal thickness of the plate forming the upper hinge-half 11, it is also possible to give different axis directions to the overlapping drill holes, in order to add and additional slight vertical component to the translation.

Figure 3 show a further embodiment of the upper half 11 of the hinge 14 in a sectioned side view as well as in a top view. In this embodiment, the upper bone screw is guided by a guiding sleeve 17, which can be moved along a slotted

hole 12, open on the upper end, and which can be clamped there in a certain range of positions and angulations. The guiding sleeve 17 has on both ends a slightly thicker diameter 18 which prevents the guiding sleeve 17 to drop out of the slotted hole 12. The clamping of the guiding sleeve 17 in the selected position is achieved by a clamping screw connection 19 which crosses a slot 20 on the upper end of the slotted hole 12 and compressed it. The axis of the hinge is marked 21 in Figure 3.

Figure 4a shows a further embodiment of the second distractor module 2. In this embodiment, the advancement of the bone segment is not achieved by means of a screw which is screwed into the bone as depicted in Figures 1a to 1e, but by a cable linkage. The upper hinge-half 11 is formed in this embodiment by a hollow cylinder 22 with a female thread 23. Into the female thread 23 a short threaded pin 24 is inserted, which can be rotated from top through the opening of the hollow cylinder 22 by means of a not shown Allen wrench engaged in an internal hex 25. In the lower part of the threaded pin 24 a thickened end 26 of a cable linkage 27 is held; this thickened end is inserted into the threaded pin 24 through a lateral slot 28. Therefore, the thickened end 26 of the cable linkage 27 does not impede

the rotation of the threaded pin 24. The cable linkage 27 is turned around in the lower area and lead to the outside and is connected on it free end to a bone screw 13.

Fig 4b. shows this second distractor module 2 as depicted in Figure 4a, in an anatomical arrangement. The turned around cable linkage 27 is screwed to the bone segment UKFS by means of the bone screw 13 and can advance the bone segment towards anterior in the case of corresponding activation. Once the frontal bone segment has been advanced until reaching the upper hinge-half 11, it can subsequently be rotated around the hinge axis 21 guided on the dentition Z in analogous fashion to the embodiments described in Figures 1a-1e. In Figure 4b the first distractor module of the distraction appliance is not depicted in detail, only a single bracket is shown as attached to dentition Z.

Figure 5a shows an embodiment of the second distractor module taking the form of a hinge, which is inserted in an anatomical arrangement in Figure 5b. Such a hinge can particularly also be used for the advancement of a segment in the area of the chin in the case of a genioplasty. In Figure 5a it is visible that the corresponding hinge-halves 10, 11 include several sequentially positioned drill holes;

furthermore, the lower hinge-half 10 has a T-shape such that the short horizontal leg provides sufficient space for three fixation holes. The Figures 5b and 5c show the arrangement in a side view and a front view prior to the start of the distraction. All screws are positioned below the hinge 14 in the lower part of the appliance. The lower screws thereby fixate the hinge 14 to the bone segment (KS), while the upper screw forms the connection to the remaining mandible. The upper screw is connected to the hinge 14 in such a way that it can freely rotate about its own axis but is held in the longitudinal direction. This constellation makes it possible to advance the hinge plate including the attached bone segment (KS) through screwing-out of the upper screw out of the threaded hole drilled into the remaining mandible, as shown in Figure 5d. This procedure is again conducted gradually, starting 5-7 days after the osteotomy, by screwing the screw every day a little bit in such manner that the bone segment (KS) is advanced by 0.5-1mm. The upper segment 4 of this second distractor module 2, i.e. the upper hinge-half 11, is again connected to the lower segment 2 by means of the hinge 14. Its function is to allow the access to the screw for activation by means of a screwdriver. The upper segment respectively the upper hinge-half sticks out of the soft

tissues passing the mucobucal fold (UF) into the oral cavity. The function of the hinge is to compensate the relative position as modified by the distraction. This would not be possible by means of a rigid upper segment. For activation, the surgeons pressed the soft tissues down, guided by the upper segment 11, until he gets access to the upper screw for activation. Thereby a light local anaesthesia might be required.

Figure 5e is a view comparable to that in Figure 5c during a chin distraction. In the top view, depicted in Figure 5f, the bone contours and the resulting soft-tissue contour (WT) is evident as it results from a conventional genioplasty. A visible discontinuity 29 results which is also visible from the outside and compromises the aesthetic result as can be seen. In the case of a distraction, on the other hand, as it is depicted in Figure 5g and which is performed using the distraction appliance according to the invention, the periosteum is slowly stretched by the gradual advancement and below the edge of the actual osteotomy surface new bone 30 is formed underneath the periosteum, which reduces or avoids the appearance of a visible discontinuity in the soft tissues.

Figure 6 is an embodiment of a further distraction appliance as example for the invention.

In this embodiment in Figure 6, which is depicted in Figure 7 arranged on a schematic mandible, again a first distractor module 1 and a second distractor module 2 are provided. The first distractor module 1 shows the typical U-shaped construction, which encompasses the mandible. In contrast to the embodiments described in the previous figures, the module has the form of an U-shaped cantilever 31, with two free legs and a transverse part 32. This U-shaped cantilever 31 is with its transverse part 32 connected to the mid-segment 3 of the first distractor module 1 by means of a connection 33.

In Figure 6 the corresponding distraction element between the end-segment and the mid-segment is marked 5. The distraction is achieved by means of a threaded spindle engaged via screw head 34. Furthermore, in this appliance a connection to the ramus 35 is foreseen on the free end of the end-segment 4. The ramus connection 25 is designed such that it can be bent and adjusted during the operation in order to arrange the distraction element parallel to the sagittal plane. Further more a lateral anchorage 36 is

provided, which serves as support for this first appliance part. The lateral anchorage 36 is inserted between the distraction element 5 and the mid-segment 3, parallel to an intermediate part 37. It is held by means of an unlockable clamp 38. The lateral anchorage 36 has an end-segment containing screw holes. The intermediate part 37 with the two clamping parts 38 on its both ends, is flexibly adaptable by means of unlocking clamps 38 in order to be able to adjust it the individual anatomy.

As mentioned, the U-shaped cantilever 31, which forms the second distractor module 2, is fixated to the osteotomised bone segment of the mandible with its free ends, for which purpose an each end of the u-shaped cantilever two fixation holes are provided.

In order to avoid discontinuities in the mandible such as corners or steps during a distraction towards ventral, this embodiment allows the creation of a natural shape of the mandible; the mandible can be spread in the anterior area. For this purpose further distraction elements 39 are inserted between the mid-segment 3 and the intermediate part 37; these linear distraction elements can be activated by means of the external hex 40. Furthermore, by means of

the clamps which hold the two further distraction elements 39 on the intermediate parts 37 and the mid-segment 3, i.e. the U-shaped cantilever 31, an adjustment can be done. The U-shaped cantilever 31 is adjustable itself around the sagittal axis.

Figures 8a and 8b show a ventral as well as a transversal distraction.

In the ventral distraction with the appliance as shown in Figures 6 and 7, the bone segment is distracted towards ventral by activation of the two distraction elements 5. In Figure 8a a distraction distance of maximal 12 mm is depicted where the distraction distance obtainable is dependent on the size of distraction element 5.

As can be seen in Figure 8b, the form of the mandible can be adapted in transversal direction by means of the two anterior distraction elements 39. As indicated in the figure, a translation by 5 mm should achievable for each distraction element 39. During this transversal distraction, it should be noted that the mandible is also widened in lateral direction in the area of the temporo-mandibular joints. Therefore this has an impact on these

joints which could be negatively affected. In order to avoid this, the screws on the section points respectively clamps 38 have to be loosened in order to allow an angular change in these connections and to unload the temporo-mandibular joints. After the translation, the screws in the clamps must be re-tightened in order to stabilize the system.

A further distractor embodiment, comparable to the one in Figure 6, is depicted in figures 9 and 10. This distractor appliance in Figure 9 features, in contrast to the U-shaped cantilever 31 in Figure 6, an essentially beam-shaped cantilever 41. Again the distraction elements 5 are inserted between the end-segments 4 and an intermediate part 37. The mid-segment 3 of this appliance is connected to the intermediate part 37 by means of a simple joint connection 42. This joint connection 42 serves the purpose of counterbalancing a correction in the frontal plane. The beam-shaped cantilever 41 takes the form of a sleeve 43 with a beam 44 pivoting inside, as is shown in particular in Figure 10 in the section. In the sleeve 43 furthermore a wire 45 is fixated, which is drawn towards cranial by the beam 44 respectively the screw 46 on the upper end. The lower end of the beam-shaped cantilever 41 is relating to a

bearing and mount 47 for the wire 45, which bearing takes the shape of a part being bent in opposite directions on both ends. While the upper bent end holds the wire 45, the lower end bent towards below serves for the fixation to the bone. If the beam 44 is screwed into the screw 46 and therefore the beam 44 pressed onto the bearing 47, the whole frontal bone segment to which the upper part of the beam-shaped cantilever is fixated, is moved towards cranial. Therefore the wire 45 pulls the base of the frontal bone segment which is solved from the mandible towards anterior. The beam 44 pushes off at the bearing 47 and moves the frontal bone segment towards cranial. Corresponding to the continuous movement of the beam 44 an overlaid translational and rotational movement is generated. By rotating the two distraction elements 5 the frontal bone segment is tilted and moved towards anterior, as it is on the lingual side pulled towards posterior by the periosteum. Therefore a hinge is not provided in this embodiment, since the periosteum and the musculature of the oral floor take over this function.

In Figure 9 one end-segment 4 is relating to a fixation element 48 to fixate this segment 4 on the ramus ascendens. This fixation element 48 is composed from a sleeve, which

can be slipped over the beam 4 which forms the end segment. On the end of the sleeve a thread is provided. This fixation element 4 can be screwed into the bone at a desired position by means of a screwdriver which is inserting into the sleeve from the free end and which engages via a slot. Subsequently the end segment is inserted into the sleeve and if desired fixated with a set screw which is note depicted.